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THE DEVELOPMENT OF MANAGERIAL MODELS

by

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One of the most critical activities of an organization is decision making. Because the decision making capacity of any organization is determined directly by the capabilities of the individuals who serve as its managers, much of the concern with improving organizational effectiveness is focused on managerial decision processes. Several considerations are relevant here, but a number of people who have considered the process by which managers make decisions have emphasized the importance which models play in this process (R5, R7). For reasons to be discussed in this paper, this emphasis has special relevance for information systems specialists concerned with developing means to augment the problem-solving capacity of these managers. Further, I believe that the evolution of information systems activities within many organizations has favored a certain view of the nature of decision-making that, with time, is becoming increasingly inappropriate for many applications.

Let me begin by drawing on some observations that Scott Morton and I made in a recent paper (R5). Consider the admittedly simplified schematic of a decision maker presented in Figure 1. In the most elementary terms, the decision maker can be considered as receiving information as "input" and producing decisions as "output". If we accept the assumption that ultimately the purpose of the management or information scientist is to improve the quality of the resulting decisions, then, in broad terms, he

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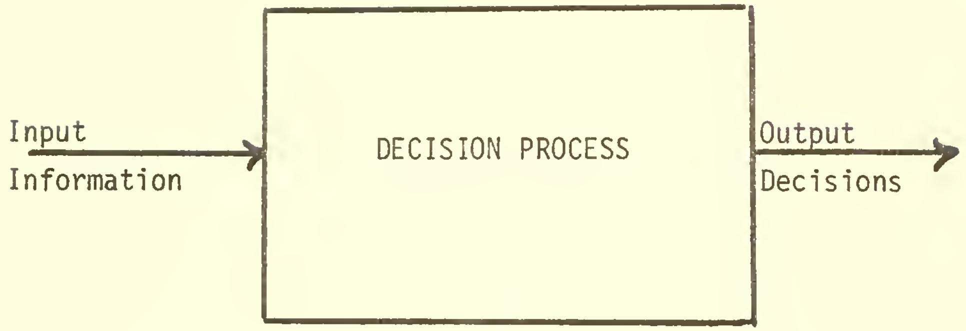


Figure 1

Elementary Representation of Decision Making

can do so by improving the quality of either the information provided to the decision maker or the process by which he deals with existing information.

To a very considerable degree, the emphasis of information systems designers has been on providing decision makers with better quality information, where quality is measured along a number of dimensions. For example, improvements in the accuracy of information can be sought. Similarly an attempt can be made to provide more detailed (less aggregate) data to management. In addition, an attempt can be made to provide information to managers more quickly, and thereby improve its "currency" at the time of use. Efforts to improve the quality of information along these or other dimensions are understandable.

In attempting to characterize the current range of computer-supported decision-making activities in organizations, Scott Morton and I found it useful to combine the ideas of Anthony and Simon. From Anthony's framework for planning and control (R2) and Simon's analysis of human problem-solving (R8), we developed the notion of structured operational control activities.

By operational control, we mean those activities directed toward the accomplishment of specific tasks in an effective and efficient manner. These tasks are the result of the day-to-day business of the organization. Typically there are significant constraints on the resources to be employed, and there exists a rather detailed statement of the objectives to be achieved. Examples of operational control activities are personnel scheduling, inventory control, and media selection for advertising.

Operational control problems are structured to the extent that a standard, routine procedure is employed to support the required decisions.

It seems fair to say that in these terms, the preponderance of information systems activities have centered on structured operational control problems. The reasons for this attention are related to the properties of the problems. That is, because of the importance and repeated occurrence of these problems in the ongoing life of the organization, it is natural to develop information systems and decision-making aids for them. Further, because the decision making process required to deal with them generally has been clear, these applications have had a strong appeal for systems designers.

The fact that models and solution procedures are known (from operations research and management science work) has promoted a strong interest in improving information quality as the primary means to improve the quality of decisions. To a large extent, the emphasis on real-time, disaggregate data collection in the operational control environment is based on the assumption that the models and procedures that exist already are satisfactory. As information systems activities expand into the domain of higher management functions, I believe that this emphasis on information quality at the expense of an emphasis on decision making models and procedures will cause important problems.

This is not to deny the importance of information quality for higher management activities. The point is that operations research and management science have not provided top management with a repetoire of

models that equips them to deal effectively with much of the information currently available to them. An interesting discussion of this failure and its causes appears in a paper by Little (R6).

For the information systems designer, this problem has important ramifications. The model of the activities of some part of an organization employed by the systems designer is a direct determinant of the information he will choose to capture in a system. For many operational control problems, there is agreement on the relevant models, and hence on the data collection and processing needs.

Far less agreement exists concerning the needs of higher management, but there is an unfortunate tendency to assume that whatever decision procedures are used by these people, improved decisions will result from a significant increase in the information provided. This seems to me to be a highly suspect assumption. Ackoff (R1) also questions this assumption.

If a manager possesses inadequate or inaccurate models of his environment, difficulties may arise beyond those associated with his inability to process effectively the information available to him. As Pounds has indicated (R7), the model a manager has of his environment is a fundamental component of his definition of problems. Pounds suggests (quite correctly, I believe) that managers "find" problems by detecting differences between their perception of their environment and their models of that environment. Such differences constitute problems which

can be solved in two basic ways. On the one hand, the manager can attempt to bring the environment into conformity with his model. Alternatively, he can alter his model so that it more closely represents the environment.

In summary, then, there are two important foundations for our interest in managerial models. First, because these models are central to managerial decision making, our enthusiasm to provide managers with more and better information should be tempered by an appreciation of their currently limited capacity to use this information effectively. As Forrester has observed (R3):

> ...many persons discount the potential utility of models of industrial operations on the assumption that we lack adequate data on which to base a model. They believe a first step must be an extensive collecting of statistical data. Exactly the reverse is true...a model should come first. And one of the first uses of such a model should be to determine what formal data needs to be collected. ...before we measure, we should name the quantity, select a scale of measurement, and in the interests of efficiency we should have a reason for wanting to know.

Not only is a model essential in assessing what information we should collect for a manager, it determines in large part the information he can use.

The second reason for our interest in managerial models is their importance in the problem-finding and problem-solving activities of management. To the extent to which ways can be found to improve these models (and a first step is to discover what they are), there is hope of directly improving the managerial performance.

The matter of developing models for use by managers is not a simple one. Little gives some reasons that models (in this case externally supplied) are not used widely by managers (R6):

> (1) Good models are hard to find. Convincing models that include the manager's control variables and so contain direct implications for action are relatively difficult to build, particularly in the areas of greatest concern...
>
> (2) Good parameterization is even harder. Measurements and data are needed. They require high quality work at the design stage and are often expensive to carry out.
>
> (3) Managers don't understand the models. People tend to reject what they do not understand. The manager carries responsibility for outcomes. We should not be surprised if he prefers a simple analysis that he can grasp, even though it may have a qualitative structure, broad assumptions, and only a little relevant data, to a complex model whose assumptions may be partially hidden or couched in jargon and whose parameters may be the result of obscure statistical manipulation.

Although I think that these observations are generally correct, I do not feel that the problems of parameterization are particularly great in many cases. In these cases, the managers may provide quite reasonable parameter assessments. If sensitivity analysis with the model shows certain parameters to be critical, then the expense and effort to make them more accurate is justified. Often much can be learned from models whose parameters are the subjective assessments of people within the organization.

In the next section of this paper, I will discuss the development of a "managerial model". There were a number of issues that assumed importance in this activity, and I want to touch on each of them briefly. In the last section, I will try to indicate the aspects of the project that I believe are representative of a more general situation.

The Case History of a Managerial Model

The project discussed here took place at one of the manufacturing facilities of a large, technically-based company which will be referred to as the Northern Company. This plant produces large, complex electronic equipment. The manufacture of this equipment is accomplished through a multi-generation assembly process requiring the coordination of many job shops. Outside suppliers contribute an important quantity of material and parts to the production process. The yearly output of this plant is approximately $200 million on a standard cost basis, and around 10,000 people are employed at the installation.

Although the plant produces relatively few different basic types of equipment, the specification by customers of special features and capabilities for these types can result in approximately 20,000 distinct configurations. In all, approximately 100,000 different parts are maintained in inventory to support this activity.

The Northern Company is a subsidiary of the United Company, and the latter is its sole customer. The major objective of the Northern Company plant in question is to provide good "service" in the sense that pieces

of equipment required by United are shipped on time by the plant. The service objective is paramount in spite of the fact that many orders from United arrive with a lead time considerably less than the 10 to 20 week manufacturing interval.

In order to achieve its service objective in the face of this short interval business, the Northern plant is required to forecast demand. The diversity in equipment details plus the specialization of the equipment quite early in the manufacturing process make forecasting extremely difficult. To a certain extent, the Northern plant is subject to what from their point of view are arbitrary, sometimes drastic revisions in production schedules. The problem is compounded by the insistence of the United management that the plant investment in inventories and work-in-process be as low as possible.

The Plant Manager is the man who is principally responsible for the performance of the production facility. Faced with contradictory objectives of good service and low investment as well as strong evaluative pressures from the management of United, he was very anxious to obtain analytical and information systems support to answer such questions as:

- What is the appropriate level of investment for a given level of production?
- Given the current situation in the plant, what would be the effects of a 10% increase in the production load?

- What would be the value of increased forecast accuracy?
- What is the basic relationship between service and investment?

Although the amount of data available to the Manager had increased enormously in recent years through the efforts of an active information systems group, he felt that he had not made much progress in answering these questions. His request for consulting help centered on finding new ways to deal with these issues.

The need for new insights into these questions had increased in recent years. The production loads were becoming more variable and the complexity of the equipment (and hence that of the manufacturing process) was increasing rapidly. Further, as the Manager looked to the future, he could see no alleviation of these trends. Finally, he felt that increasingly he was forced to make decisions based on *assumed* answers to questions such as those above, and he was concerned that his assumptions were incorrect.

During conversations with the Manager and his staff, it became apparent that it was important to investigate their model of the production system. In view of the increasing difficulty they were having with required decisions, it seemed that their understanding of the interactions among control variables and consequences might be inadequate. This feeling was strengthened by their inability to articulate clearly their understanding of these interactions.

One possibility that was suggested was that of proceeding directly with the development of a large scale simulation model of the plant. Because the Northern plant had no experience with such models and hence had no internal evaluative capacity to assess potential costs or benefits, there was a reluctance to undertake this effort. Further, the Manager needed immediate assistance, and therefore he was inclined to assign priority to a project with a shorter development time.

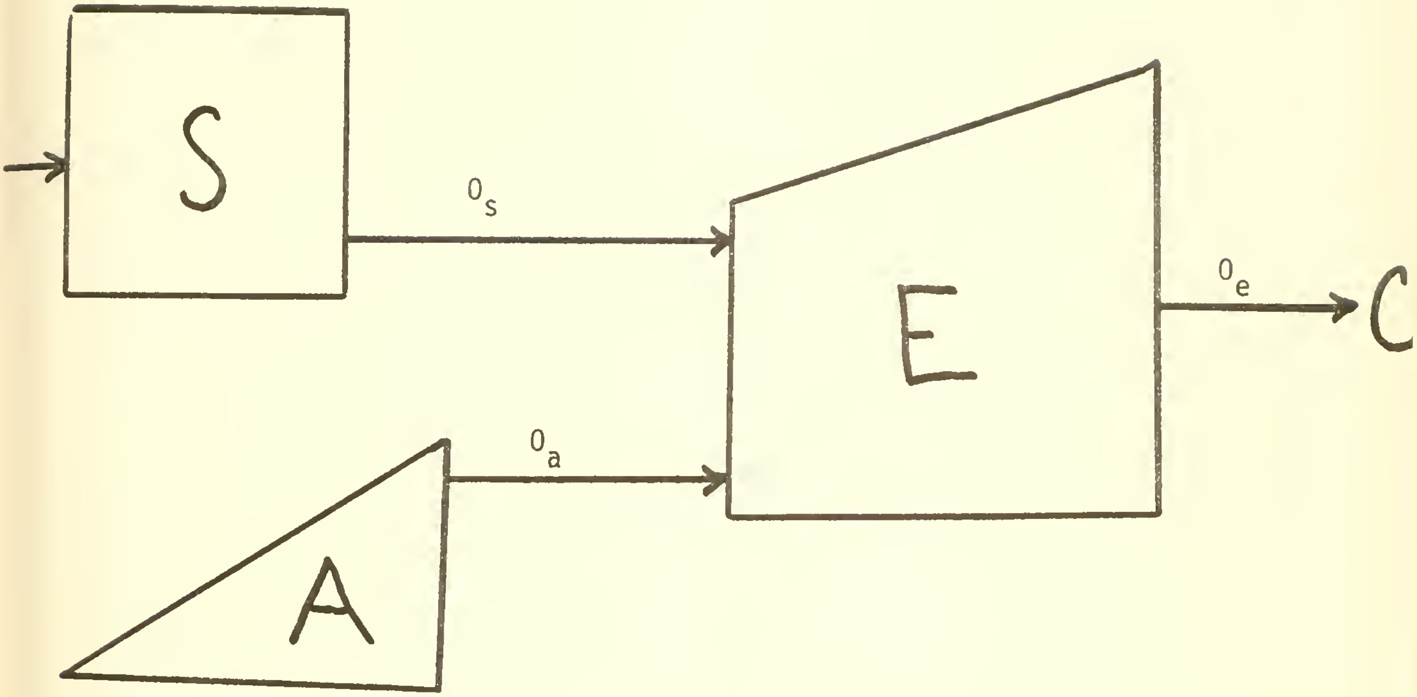
We decided, then, to undertake the formulation of an analytical model to be completed within a relatively short time period. It was understood that the resulting model necessarily would be very approximate and incomplete. Nevertheless, in view of the recurrent serious problems confronting the Manager and his staff, it was thought that even a limited model would prove useful. Also, an aggregate model would provide a framework within which more detailed models of various aspects of the process could be developed later.

The major difficulty in this undertaking was the question of how to come to grips with the considerable complexity of the manufacturing process at the plant. Because of my unfamiliarity with operations there, I turned to the Manager as a source of valuable descriptive information. Although there was reason to believe that he was not fully aware of the dynamics of the process, in questions of aggregation, variable identification and parameterization, he should have much to contribute.

In a first step, an attempt was made to elicit from the Manager his "model" of the plant. Because there was considerable discussion between us in this activity, it is misleading to call the resulting model the Manager's model. There is little evidence that he had previously used this model in thinking about the plant. Properly the model can be said to be my representation of his comments in a convenient form that he accepted as correct in gross terms.

The gross nature of the first model is apparent from the basic assumptions we made. First the entire manufacturing facility was considered to be two job shops and a storeroom as depicted in Figure 2. Further, no product mix was considered; the only units measured were aggregate dollars. Basically, the manufacturing process denoted by "A" in Figure 2 represented all piece parts and apparatus manufacture. Raw materials were assumed to enter this process at zero cost. (This is because the principal costs here are for labor.) Labor value was assumed to be added linearly over the duration of the manufacturing interval (taken as an average interval). Flowing into the storeroom, denoted by "S" in the figure, were parts from the outside suppliers denoted by "P".

The process denoted by "E" represents equipment manufacture. The input flow to this process is from the storeroom and from the apparatus shop. Again it was assumed that labor value is added linearly over the manufacturing interval. The output flow from this process goes to customers, "C".



For INV = investment and

1) T_S = average lead time for parts

2) T_A = average manufacturing interval in shop A

3) T_E = average manufacturing interval in shop E

we assumed:

$$INV_S = \frac{1}{2} \cdot 0_s \cdot T_S$$

$$INV_A = \frac{1}{2} \cdot 0_a \cdot T_A$$

$$INV_E = \frac{1}{2}(0_s + 0_a + 0_e) \cdot T_E$$

and

$$INV = INV_S + INV_A + INV_E$$

Figure 2

The First Model

The Manager estimated the various flows and intervals in the model assuming current business conditions. For example, with the weekly production at $3 million, he estimated that 0_S and 0_A were each about $1 million. Further, he thought the average interval in the two shops was 10 weeks; and the average lead time for parts, about 12 weeks. From these estimates, it is a simple matter to obtain an estimate of overall investment of $36 million.

The actual investment at that time was around $38 million, but if was thought that between $1 and 3 million of that was "junk" that would be written off at the end of the year.

Clearly this simple investment calculation is only of marginal interest *per se*. Its importance stems from the intuitive appeal it had for the Manager and the relative ease with which it can be elaborated. With regard to the first of these points, it should be noted that, other than a few charts and correlations based on past history in the plant, the Manager had *no* formal representations of the relationship among investment, output, and manufacturing intervals.

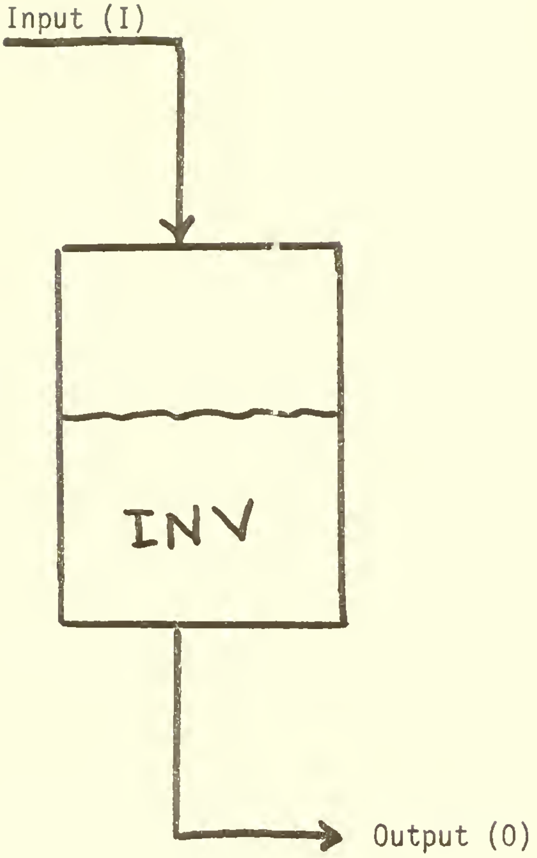
As a next step, it seemed appropriate to elaborate this model somewhat. The major shortcoming of the model as far as the Manager was concerned was its static nature. He felt that his problems would be minimal if the flows depicted were constant over long periods of time. Most of his problems stemmed from the dynamics of the production system.

Keeping the same level of aggregation, we made the model dynamic in the following way. First, the two shops and the storeroom were represented by constructs that we called accumulation centers (see Figure 3).

The Manager found it convenient to think of an accumulation center as a tank of water with an input line and an output line. For any small time interval, the change of volume of the water in the tank is determined by the difference between the input flow and the output flow. In general, the output rate is taken to be proportional to the volume in the tank.

The determination of the input rate is slightly more complicated. Basically the input is controlled to achieve a desired output. Hence, as the desired output rate changes, the desired input does also. For the processes of interest here, however, this adjustment of the input rate cannot be effected instantaneously. The desired input rate is achieved only after some delay. Schematically, the response of the actual input to a change in desired input is shown in Figure 4. These responses were represented as third order delays in the model.

When the accumulation centers corresponding to apparatus/parts manufacturing, outside parts supply, and equipment manufacturing were related to one another, certain modifications of the above constructs were required. The basic model is depicted in Figure 5. The independent variables are the forecasted and the actual manufacturing loads. Given these values over time, the model generates investment levels and output rates. Consider the dynamics of this process in terms of Figure 5.



$$\frac{d(INV(t))}{dt} = I(t) - O(t)$$

$$O(t) = k \cdot INV(t)$$

Figure 3

Accumulation Center

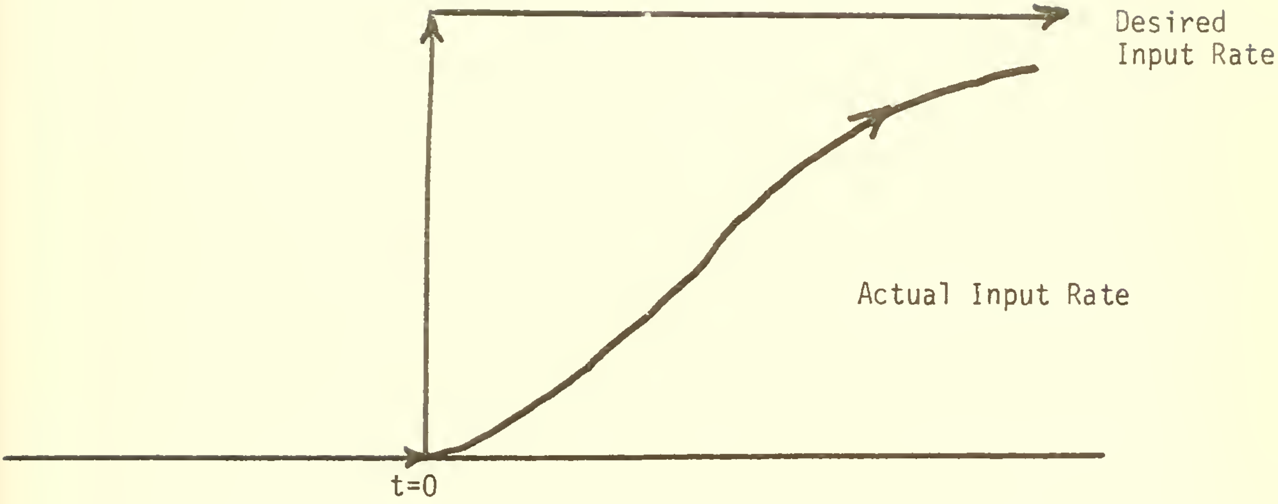
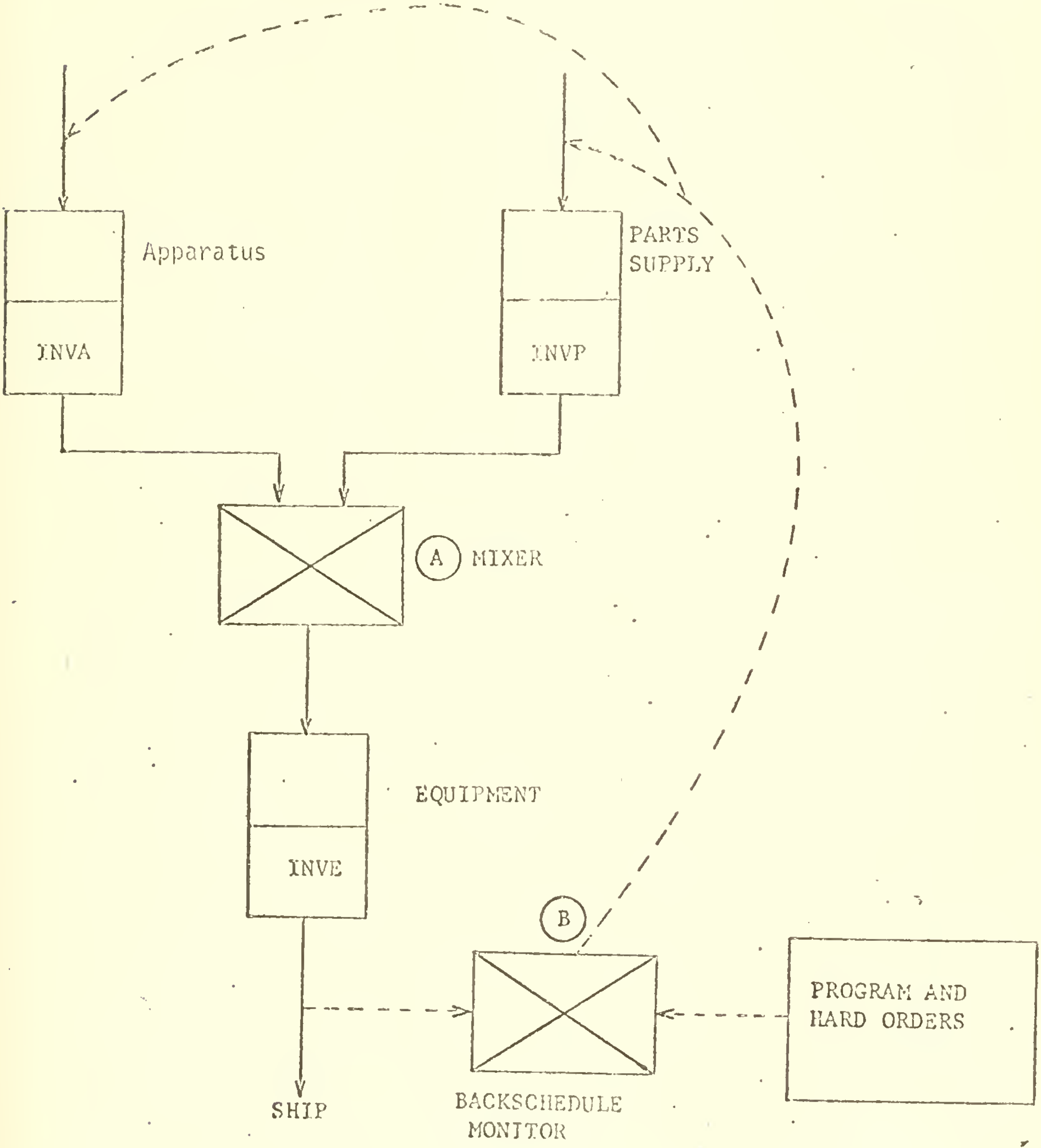


Figure 4

Response of Actual to Desired Input

FIGURE 5. SCHEMATIC OF MODEL



The forecast load for the future is used as the basis for setting the desired input rates for the apparatus manufacturing and parts supplies centers. (This corresponds to actual practice in the plant.) The amount of back schedule (late orders currently in the plant) also influences these rates as will be seen. As the desired input levels change, the process delays determine the rates at which the actual input levels change in response. Thus, the inflow of parts gradually increases in response to anticipated increases in load as does the work in process in apparatus manufacturing. In the model, the desired input rates at these two centers are taken as constant fractions of the forecasted load plus an allocated portion of the current back schedule. The required constants were estimated by the Manager.

The investment in these two centers is depleted to provide input to the equipment manufacturing center. The decision block labelled A in Figure 4 serves to guarantee that the two streams are mixed in proper proportion. An increase in the desired input rate to the equipment center generates an increase in actual input in accordance with the delay for that center. (The flow into this center, however, may be limited by the output rates of the two supply processes.) At any time, the output of the equipment center is proportional to the investment in the center.

The block labelled B in Figure 5 monitors the output from the equipment center and compares it to actual requirements. If the output (which is principally determined by the anticipated load) fails to match

the requirements, the back schedule position is affected. The model maintains a record of the current backschedule and uses it to modify the forecast as a basis for generating desired input rates for the apparatus manufacturing and parts supply center. This completes the basic feedback loop in the model.

The assumption of the linear addition of labor value in the two manufacturing centers was retained. Further, it was assumed that the delay constants were not affected by the load.

Before presenting some results which were obtained using this model, I want to make some observations about it relating to the discussion of the first section of this paper.

First, the model is descriptive, not normative. It is one representation of the process as it is, not as it should be. The motivation for this approach lies in the "black box" representation of the managerial decision maker presented above. I suggested that one way to improve the decision-making process represented by that box is to improve the model of the environment it contains. My discussions with the Manager led me to believe that he did not employ a particularly good model of the manufacturing system in his considerations.

Because there was no possibility to provide him with automatic decision-making for any of his activities in the short run, it was imperative that he understand any model that he would use. The model I have presented meets this requirement. The Manager understood the

building blocks, then functions, and their structural connections. Furthermore he accepted them and was aware of the assumptions and simplifications made.

Finally, we did not require an extensive data collection and analysis effort before the model could be used. The parameters were estimated easily, and close agreement existed among the estimates of a number of people experienced with the plant and its operation.

The Use of the Model

The set of equations implied by the model were incorporated into a computer program. As noted, the necessary parameters were set in accordance with the opinions of the Manager. The program also required a pattern of forecasted business and a pattern of actual business received. It produced graphical patterns of investment and output (in dollar terms) over time. In Figure 6, the results of one run are presented in terms of aggregate investment and output for the period from the beginning of 1965 to the beginning of 1969. Notice that although the model is a simple one, it produces complex patterns of investment and output. I will return to the importance of this fact later.

The problem of assessing the degree to which the model is a "good" one is interesting. As I observed in another context (R4), in the final analysis, judgments of the validity of a model depend very strongly on the use to which the model is to be put.

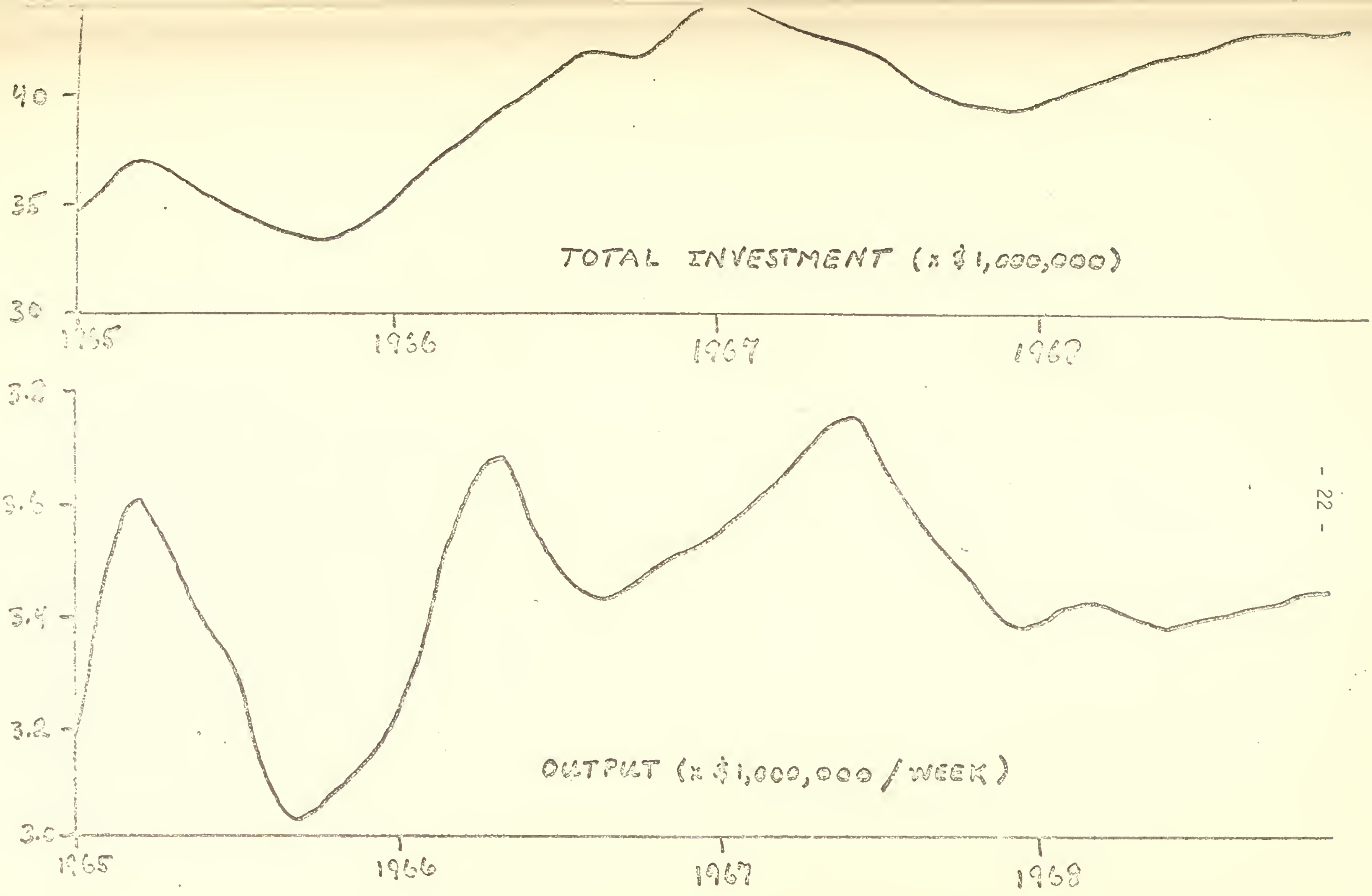


FIG. 6: SAMPLE MODEL OUTPUT

The intended use of this model was to improve the Manager's understanding of his environment, and hence to improve his ability to make planning and control decisions. For this purpose, the model should capture the basic dynamic behavior of the system, but it need not "explain" all the observed complexity of this behavior. Nonetheless, the patterns produced by the model are remarkably similar to the historical patterns for the plant. Generally the investment and output values are within 5 - 10% of those actually experienced and the peaks and troughs of the model patterns occur within a few weeks of the actual ones. The Manager needed no elaborate statistical tests to convince himself that the model indeed captured the basic, aggregate behavior of the production system.

With the model in hand, we could begin to investigate some of his assumptions about the effect of various decisions on the system.

For example, in response to increasing pressure from the management of United to decrease his aggregate investment, he was considering stopping all parts orders for a period of time. He recognized that because he could not control actual load, that his service position would deteriorate. Faced with increasing investment in the plant and seeing no other way to reverse this trend, however, he was prepared to accept the assumed consequences. He felt that the plant would "recover" from this disruption within 10-15 weeks.

Although the model does not account for product mix which is an important factor in this regard, it was decided to use it to get a gross assessment of his planned action. We assumed a variety of future loads

differing from the forecast in a number of ways. Then for comparative purposes, the model was run on the assumption that no special action would be taken. Then to evaluate the planned course of action, we again ran the model with a forecast of zero load for the time period in question. The assumed patterns of actual orders were retained.

The results were very surprising to the Manager. Although the total flow through the process was the same in the two cases, the Manager's course of action led to markedly higher variance in the investment and output levels. Further, the time interval over which this effect was noticeable was more than one year as contrasted with his estimate of 10 - 15 weeks.

There is no way to infer directly from these results that one policy is to be preferred. The Manager's experience is critical. He clearly preferred the "no action" policy, because he knew that significant costs were associated with rapid, large changes in investment and output. Further, the model indicated that for the range of forecast-actual load patterns he considered reasonable, the current increase in investment was a transient effect leading to a sharp rise in output and a concomitant decrease in investment.

Despite the fact that his plan of action was contraindicated by the results of the experiment with the model, the Manager still felt that the model was valid. He believed that it was sound and that it reflected his view of the plant. On the other hand, he felt that although he could

identify the important components and parameters of the model, he did not have a firm intuitive understanding of the consequences of their interaction. His decision not to restrict the parts supply was a direct result of these feelings.

This underscores the point I made in the first section of this paper about the importance of the decision maker's understanding of any model he uses. The Manager retained the responsibility for the decision and he served as the evaluator of the results. If the model was to be useful in this context, he had to understand and accept its components and their relationships. Admittedly, he did not understand the dynamics of the model (at least initially), but he did accept each equation employed in the computer program. The fact that these equations could be related to the model components directly in a way the Manager could accept was crucial. Basically the model was useful to him only because he had made an evaluation of its validity.

The model was useful in a number of other situations as well. I want to outline two of these briefly to show the pervasive influence of managerial models.

For some time a project had been underway within the Northern plant to define appropriate control variables through which the Manager could monitor and influence the manufacturing process. The intention was to provide the Manager with information systems support in the form of measurements of these variables once they were defined.

There was a very strong tendency to restrict the search for such indicators to the set of those traditionally accepted as being significant. As an example, it was felt that "weeks of stock", a moving average of the investment divided by the output rate, was an important control measure. The Manager felt that he should attempt to operate the plant at 10 - 11 weeks of stock. As a result, the intention was to provide him with more rapid and accurate measurements of this variable. Past variations in this quantity were assumed to have resulted from improper control of the process.

By using the model for a variety of assumed load patterns, the Manager convinced himself that this quantity of itself was virtually useless as a control indicators. Systematic variations of weeks of stock are to be expected. Further these variations are determined by the phase differences between investment and output patterns. These differences, in turn, reflect the process delays. Thus, unless these effects are considered, no normative statements about weeks of stock can be made. Similarly the model provided the Manager and systems people with new insights into the value of other traditional process measures.

Again this relates directly to a point discussed in the introduction. Because the systems designers had no good model of the process, they could not make reasonable assessments of the potential value of information. It was apparent that some of the effort they had expended on systems design would have been better spent had they done more systems analysis and

modeling. Also, this modeling effort would not have been necessarily great as I have indicated. The benefits, however, would have been significant.

Another use of the model was in a meeting between a Vice President of Northern and the Manager. The former had exerted strong pressure on the Manager to reduce investment in inventories and work in process. At the same time, he felt that the plant should be able to respond to sudden changes in load more effectively.

The Vice President accepted the basic structure of the model (explained by the Manager) and felt that it would be a useful vehicle to get some general understanding of the dynamics of the production system. Of particular interest to him were questions of the ability of the plant to respond to increases in business within a short time horizon and the effect of an increased willingness to operate in a backschedule position on investment variations.

Although no specific decisions were made as a result of this meeting, both men stated that the communication between them had been significantly better than in the past. They attributed this improvement to the availability of an "objective" means to evaluate the consequences of their assumptions. They felt that in the past, arguments about "solutions" had not been recognized as properly having been arguments about models. With a commonly accepted model, they could focus more clearly on alternative courses of action.

There were some other interesting uses of the model, but they will not be discussed here. The important point is that these uses underscored the uses and general importance of a formal model of the system in many of the Manager's activities.

Conclusions

The development of the model discussed above, of course, is but one experiment. As a result, certain care must be taken in drawing general conclusions from the results. On the other hand, I feel that this study tends to confirm some of the observations made at the beginning of this paper.

First, as I have noted, the Manager's model of his environment is an important factor in both his problem findings and problem solving activities. Further it appears that although the dynamic model is a simple one, it represents a marked improvement over the model he previously employed. This feeling is supported by the Manager's enthusiasm for the new model. In large degree, he is the evaluative mechanism for assessing the validity of the model. That is, much of the question of validity depends upon his acceptance and use of the model, and his feeling that he performs his function better with the model than he did without it.

Therefore it was essential that the model be sufficiently simple for the Manager to understand. Here simplicity is to be judged in his terms, not in mine. I believe that these observations have a general relevance to management science and information science work in unstructured decision making.

Another point is that although additional information might have aided the Manager, most of his problems stemmed from his inability to deal effectively with the information currently available to him. He had no difficulty in providing the parameter assessments required in the model or in understanding its basic constructs, but he could not predict the results it would produce.

I have observed this phenomenon in another context, namely medical decision making. In informal experiments in this area, I have seen a marked difference in the ability of doctors to estimate parameters of a model (in this case probabilities) and their ability to predict the results the model would produce. This is true despite the fact that the model is a simple one that is known to them.

This raises an interesting possibility. In developing a managerial model, one should be careful not to assume that a manager's inability to make good decisions implies that he cannot make good parameter estimates. I believe that in many cases, managers constitute a rich source of descriptive information despite their unimpressive decision making performance. By drawing on this source, a significant data collection and analysis effort may be avoided. After the sensitivity of the model to these parameter values has been investigated, the value of refined estimates can be determined more rationally.

I also believe that the educative value of managerial model building often is underemphasized. Many discussions of formal models have stressed the value of explicit statements of assumptions. Many information systems

people, however, in their emphasis on improved management decisions tend to judge the value of models in terms of specific decisions which must be made. Educative models ultimately can improve managerial effectiveness by providing a better representation of the environment, but the benefits may accrue over relatively long periods of time and in unanticipated ways. My concern is that desire for a definite, immediate payoff from a modeling effort will divert attention from the need for improved understanding of the environment in general.

Finally, the experience at Northern suggests an important point about the design of information systems for unstructured management problems. I strongly support Forrester's contention that the model should precede information collection. The value of information is determined in the final analysis by the changes in decisions it produces. A central element of a managerial decision process is the model of the environment, and therefore this model is vital in the determination of the value of information. Of course, it may be advantageous to change or improve this model, but simply increasing the flow of information to a manager without analyzing his capacity to process it is a waste of energy and resources.

In summary, then, I would call for a more active concern with the models available to managers. This concern should be motivated by both the general importance of these models in managerial activities and by the currently underdeveloped models employed by many managers. At the same time, I feel that the constraints on this modeling activity suggested in this paper must be acknowledged and observed.

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